Asthma and Enrollment in Special Education Among Urban Schoolchildren

Jeanette A. Stingone, MPH, and Luz Claudio, PhD

Objectives. We assessed whether asthma is associated with urban children's use of special education services.

Methods. We conducted a cross-sectional study in 24 randomly selected New York City public elementary schools using a parent-report questionnaire focusing on sociodemographic characteristics, special education enrollment, asthma diagnosis and symptoms, school absences, and use of health care services.

Results. Thirty-four percent of children enrolled in special education had been diagnosed with asthma, compared with 19% of children in the general student population. After control for sociodemographic factors, children with asthma were 60% more likely than children without asthma to be enrolled in special education (odds ratio [OR] = 1.62; 95% confidence interval [CI] = 1.22, 2.16). Asthmatic children in special education were significantly more likely to be from low-income families and to have been hospitalized in the previous 12 months than asthmatic children in general education.

Conclusions. Inadequate asthma control may contribute to a greater risk of asthmatic children residing in urban areas being placed in special education. School health programs should consider targeting low-income urban children with asthma at risk for enrollment in special education through increased asthma interventions and medical support services. (*Am J Public Health.* 2006;96:1593–1598. doi:10.2105/AJPH.2005.075887)

School-based cohorts and school-related outcomes are important to understanding the epidemiology of disease in children 5 to 12 years of age. One highly prevalent disease among schoolchildren is asthma. Asthma is the most common chronic childhood disease in the United States, and it is the leading cause of school absences.[1] It has been estimated that health care expenditures are almost 3 times as high among children with asthma as among children without the disease.[2] In addition, asthma severity, low family income, and non-White race/ethnicity have been associated with increased asthma-related costs to both families and managed care companies as a result of increased use of health care services.[3]

However, cost estimates do not take into account expenditures associated with special requirements associated with the education of asthmatic children. School absences and other effects of asthma may lead to children requiring special education services, compounding asthma-related costs. The average yearly cost per special education student in New York City for the 2001 school year was $28 810, compared with $8944 for the average general education student.[4] Compounding this situation is the fact that once children are placed in special education, it is unlikely that they will enter or reenter the general education environment. Although the reasons are unclear, New York City has the lowest rate of reentry of special education students in the state, regardless of disability.[5]

Children are enrolled in special education for a number of reasons. For example, in New York, students are eligible to receive special education services if their educational performance is adversely affected by a state-recognized disability such as autism, hearing impairments, emotional disturbances, learning disabilities, mental retardation, orthopedic impairments, speech or language impairments, traumatic brain injuries, or visual impairments.[6]

The relation between asthma and learning disability is not clear. One study showed that asthmatic children whose parents reported them to be in fair or poor health were more likely to have a learning disability than asthmatic children in good or excellent health.[7] Because low-income urban children are more likely to experience higher levels of asthma morbidity, these results suggest that they are at a higher risk of school and learning difficulties as well.[7] A study conducted in New York City showed that 40% of parents enrolled in an asthma management program reported school problems among their asthmatic children.[8] However, the researchers did not define what they considered to be "school problems," nor did they examine other factors associated with such problems.

In New York City, approximately 163 000 students are enrolled in some form of special education.[9] Special education services range from a period of extra help in a resource room program during the school day to fully segregated special education classrooms. Children enrolled in special education generally exhibit worse academic outcomes than their general education counterparts. For example, only 44% of fourth graders in special education achieved a score of proficient or higher on the 2005 New York State mathematics examination, compared with 77.4% of general education students.[10]

Our objective was to assess the relation between asthma among urban children and enrollment in special education in New York City public elementary schools. We also sought to examine the socioeconomic and disease-related factors associated with enrollment in special education programs among asthmatic children living in this urban area.

METHODS

We conducted a cross-sectional study in randomly selected New York City public elementary schools during the 2002–2003 school year in an attempt to determine asthma prevalence in those schools.[11] Information on

children's use of special education services was obtained as part of the study.

Study Design/School Selection

To ensure that schools with different asthma rates were included in the study, we calculated asthma hospitalization rates for the year 2000 among children aged 5 to 12 years in each of New York City's residential zip code areas using data obtained from the New York State Statistics Planning and Areawide Research Council database and the methodology described in a previous study.[12] We then used these hospitalization data to order and stratify the zip code areas into 15 groups approximately equal in size. The areas with the highest, median, and lowest childhood asthma hospitalization rates were selected for inclusion in the study. The highest group comprised zip code areas with hospitalization rates ranging from 86.3 to 163.2 per 10 000 children; the median group comprised areas with hospitalization rates ranging from 28.9 to 35.7 per 10 000 children; and the lowest group comprised areas with hospitalization rates ranging from 0 to 4.99 hospitalizations per 10 000 children.

Enrollment data from the 2001–2002 school year for public elementary schools located within each of the 3 zip code–defined groups just described were obtained from the New York City Department of Education. Magnet schools and other schools of choice were not included, because children attending these schools often do not live in the same neighborhood as the school. These listings were used to randomly select 1 school in each zip code area in the 3 groups via probability-proportional-to-size methodology (SAS 9.0; SAS Institute, Cary, NC). This school then became eligible to participate in the study. We selected 26 schools overall, 8 each from the high and median groups and 10 from the low childhood asthma hospitalization rate group. We oversampled in the low group to compensate for the expected lower asthma prevalence rates in these areas. Two schools, one in the low and one in the median group, in which no students were enrolled in special education, were excluded from the analyses.

Within each school, 2 classrooms at each grade level (kindergarten through grade 5) were randomly selected to take part in the study. Two full-time special education classrooms per school were also included in the study when possible. In each classroom, students were given questionnaires to take home and be completed by a parent or guardian. Children and teachers were given nominal incentives, consisting of school supplies, to encourage participation.

Questionnaire

The questionnaire was adapted from one used in an earlier study of asthma prevalence in a New York City public elementary school.[13] It contains standardized questions on demographics, household environment, and asthma symptoms from the International Study of Asthma and Allergies in Childhood.[14] Parents or guardians of asthmatic children also answered questions on symptom frequency during the previous 2 weeks, use of medical services, school absences, insurance status, and medication use in the previous 2 weeks.

Classification of Children With Asthma

Children were identified has having a history of asthma if their parent or guardian answered yes to the following question: "Have you or your child ever been told by a doctor or a nurse that he/she has asthma?" Children were classified as currently having asthma if their parent or guardian also answered yes in response to "In the last 12 months, has your child had wheezing in the chest?" Analogous questions were posed to document a physician's diagnosis of allergies and chronic bronchitis. The presence of asthma-related symptoms without an asthma diagnosis was also assessed via questions from the International Study of Asthma and Allergies in Childhood inquiring about history of wheezing, wheezing in the previous 12 months, and nighttime symptoms that disturb sleep.[14]

Classification of Special Education Students

Children were classified as receiving special education services if their parent or guardian answered yes to the following question: "Does your child currently attend special education classes either part time or full time?" If a child's parent or guardian answered yes to this question but the child was not in a previously designated full-time special education classroom, the child was classified as receiving "part-time" special education services. All children who were enrolled in full-time special education classrooms were classified as such.

Data Analysis

We weighted the data to represent the number of children attending public elementary schools within each selected zip code area according to school enrollment data from the 2001–2002 school year, the most recent enrollment data available at the time the study was conducted. We calculated descriptive statistics for demographic characteristics and prevalence estimates using SAS Survey procedures. These methods accounted for the sampling design's clustering by school and stratification by neighborhood asthma hospitalization rate.

The SVY commands in Stata 8.0 (Stata Corp, College Station, Tex) were used in making asthma prevalence comparisons between children in general education and children in special education. These commands calculated test statistics (χ^2 statistics for categorical variables and Wald test values for continuous variables) corrected for the study's design. Univariate associations between use of special education services and demographic factors were calculated according to the same procedures.

Using Stata software, we calculated adjusted odds ratios (ORs) in a logistic regression model, constructed via manual backward elimination, that accounted for the sampling design. All factors shown by the univariate analyses to be associated with use of special education services were initially included in the model. Significance was determined at the $P<.05$ level. To identify risk factors that might contribute to the association between special education and asthma outcomes, we created additional models using measures of asthma morbidity as the dependent outcome variables with enrollment in special education entered as an indicator variable. Again, we used manual backward elimination in constructing these models.

RESULTS

Results from 4899 usable questionnaires were analyzed. After adjustment for the

TABLE 1—Demographic Characteristics of Study Population, by Educational Placement: New York City Elementary School Students, 2002–2003

	Special Education (n = 355)[a]	General Education (n = 4544)[a]
Male, %**	57.8	45.3
Mean age, y*	8.70	8.07
Ethnicity, %		
Hispanic	42.9	40.4
Dominican	9.01	6.67
Mexican	6.89	4.53
Puerto Rican	17.7	11.6
Other Hispanic	9.27	17.6
African American	19.6	24.7
White	13.4	10.8
Asian	13.3	13.3
Other	6.44	7.63
Income, $, %***		
≤20 000	49.5	39.0
20 001–39 999	25.2	26.9
40 000–74 999	6.86	14.8
≥75 000	2.57	6.17
Caregiver educational level, %**		
Less than high school	24.8	16.8
High school or equivalent	29.9	28.6
Some college or trade school	22.1	25.5
College or more	17.1	23.4
Exposure to household tobacco smoke, %***	33.1	22.8

[a]Nonresponders were included in the denominator; thus, some categories do not equal 100%.
*P < .05; **P < .01; ***P < .001.

TABLE 2—Asthma and Related Conditions (%): New York City Elementary School General Education and Special Education Students, 2002–2003

		Special Education		
	General Education (Overall; n = 4544)	Full Time (n = 84)	Overall (n = 355)	Part Time (n = 271)
History of asthma**	19.3	34.0	28.9	26.9
Current asthma*	11.9	26.3	18.3	14.8
No asthma diagnosis				
History of allergies	16.7	21.8	20.1	19.5
History of chronic bronchitis	1.86	0.00	1.72	2.37
History of wheezing	6.57	2.59	6.72	8.30
Wheezing in previous 12 mo	2.76	1.66	3.10	3.72
Symptoms disturbing sleep in previous 12 months	4.18	.687	3.87	5.24

*P < .01; **P < .001 (for comparison between general education and overall special education).

average absence rate of the schools included in the study,[15] the response rate was 76.9%. Among children enrolled in full-time special education classes, the response rate was 70.0%.

Study Sample Demographics

The data showed that selected schools were representative of their surrounding neighborhoods. The ethnic backgrounds of the student populations of 22 of the 24 schools included were closely similar to the backgrounds of the surrounding zip code areas. In addition, our overall sample was comparable to the overall New York City elementary school population in terms of demographic characteristics.

The apparent discrepancy in the percentage of African Americans (24% in our sample vs 32.7% in New York City as a whole; P< .001) can be explained by differences between our racial/ethnic categorization and the one used by the New York City Department of Education. New York City Department of Education data do not include a multiracial category, and the "other" race/ethnicity category refers only to Native Americans. In contrast, one third of the "other" race/ethnicity category in our sample consisted of multiracial children of African American descent or children of African descent. Almost 4% of our sample did not specify a racial/ethnic category. Also, male students were underrepresented in our sample (46.6% vs 51.3% in New York City as a whole; P<.001).

The parents or guardians of approximately 8% of the overall study population reported that their children received either part-time or full-time special education services. Table 1 presents a comparison of the demographic characteristics of special education and general education students. Children receiving special education services were more likely to be older and male, to live in low-income households, and to have a caregiver with less than a high-school education. In terms of overall racial/ethnic composition, special education students were not significantly different from the general school population, although African Americans were underrepresented in the special education population.

Asthma Prevalence

We calculated asthma prevalence estimates for both special education students (full time as well as part time) and general education students (Table 2). The highest prevalence of both a history of asthma and current asthma were observed among full-time special education students, followed by part-time special education students and the general education population. Overall, asthma prevalence was significantly higher among special education students than among the general education population. Among students without an asthma diagnosis, there were no significant differences between special and general education students in prevalence of allergies or chronic bronchitis or asthma-related symptoms such as wheezing (Table 2).

After adjustment for age, gender, ethnicity, income, and exposure to environmental tobacco smoke in the home, students with asthma were more than 60% as likely as students without asthma to be enrolled in special education (P=.002; Table 3). Overall, Hispanic students had the greatest risk of enrollment in special education (OR=1.88; 95% confidence interval [CI]=1.17, 3.04). Parents' educational level was not significantly associated with enrollment in special education and was excluded from the final model.

To assess the temporal relationship between an asthma diagnosis and placement in special

TABLE 3—Multivariate Analysis of Risk Factors for Enrollment in Special Education: New York City Elementary School Students, 2002–2003

Characteristic	Odds Ratio (95% Confidence Interval)	*P*
Gender		<.001
Male	1.84 (1.35, 2.50)	
Female	Reference	
Ethnicity		
Asian	1.40 (1.00, 1.99)	.056
African American	1.03 (0.69, 1.53)	.896
Dominican	1.75 (0.96, 3.17)	.064
Mexican	1.56 (0.74, 3.30)	.232
Puerto Rican	1.91 (1.02, 3.57)	.044
Other Hispanic	2.04 (1.46, 2.84)	<.001
Other	1.21 (0.43, 3.54)	.717
White	Reference	
Income, $		
≤20 000	2.06 (1.24, 3.44)	.008
20 001–39 999	1.62 (0.90, 2.90)	.099
40 000–74 999	0.91 (0.50, 1.65)	.740
≥75 000	Reference	
Exposure to household smoking	1.57 (1.29, 1.93)	<.001
Age	1.15 (1.00, 1.32)	.044
Current asthma	1.62 (1.22, 2.16)	.002

TABLE 4—Asthma Management Among New York City Elementary School General Education and Special Education Students, 2002–2003

	Special Education (n = 60), %	General Education (n = 417), %
Hospitalization in previous 12 months**	18.3	6.9
Emergency department visit in previous 12 months*	54.9	44.1
Peak flow meter use*	16.0	32.1
Spacer use	41.2	47.4
School absence in previous 2 weeks	23.8	20.9
No. school days missed over a given 2-week period	4.0	2.8
Use of medications in school	34.2	28.4

*P < .10; **P < .05.

education, we constructed another model that focused only on children who had been diagnosed with asthma before entering school (before their fifth birthday). Thus, this model included only children placed in special education after receiving an asthma diagnosis. As revealed in the analysis that included all children, there was a significant association between asthma and enrollment in special education in this group as well (OR = 1.52; 95% CI = 1.19, 1.95).

Characteristics of Asthmatic Students Enrolled in Special Education

Asthmatic children enrolled in special education were older (8.86 years vs 8.1 years; P = .002) and more likely to live in households with annual incomes below $20 000 (61.0% vs 38.5%; P = .035) than were students in the general school population. We found no significant differences in racial/ethnic backgrounds between asthmatic children in special education and asthmatic children in the general population. In addition, there was no significant difference between the 2 groups in average age of asthma diagnosis (general education students: 34.1 months; special education students: 31.4 months).

Data on differences in aspects of asthma management between asthmatic children enrolled in special education and those in the general population are presented in Table 4. Hospitalization because of asthma in the previous 12 months, an indicator of poor asthma control, was reported among 3 times as many children in special education as among general education students. Special education students were 15% less likely than general education students to use a spacer (a tube-like chamber that attaches to inhalers and helps deliver medication to the lungs) and half as likely to use a peak flow meter (a device that measures the ability of the lungs to push out air), both beneficial asthma management devices.

Although the percentages of children missing school during a given 2-week period as a result of asthma were similar, special education students missed, on average, an additional day of school relative to asthmatic children in the general population. Also, special education students were more likely to use medications during school hours, leading to missed class time, although this finding was not statistically significant.

African American or Hispanic race/ethnicity and living in a household with an annual income below $40 000 were independent risk factors for use of urgent care emergency department services. However, enrollment in special education did not predict emergency department or hospital use after adjustment for ethnicity and income (OR = 0.90; 95% CI = 0.41, 1.97). Enrollment in an asthma management or asthma education program was associated with increased use of peak flow meters among all children, regardless of whether they were receiving special education services (OR = 5.41; 95% CI = 2.43, 12.00).

Results revealed that race/ethnicity, household income, and other socioeconomic variables did not predict medication or spacer use among children in either general or special education. Similarly, we found no significant difference between asthmatic children in special education and those in the general population in number of symptoms reported during the previous 12 months or the previous 2 weeks, nor did we find any significant differences in current medication use.

DISCUSSION

Our primary finding was that children with asthma were 60% more likely to be enrolled in special education than children without asthma after adjustment for ethnicity, income, and other demographic factors. Our results suggest that inadequate asthma control may contribute to increased placement of children in special education.

Inadequate Asthma Control and Special Education Enrollment

This study shows that children with asthma who were enrolled in special education were

significantly more likely to have been hospitalized in the previous 12 months than other asthmatic children and were also more likely to have visited an emergency department in the previous 12 months as a result of asthma symptoms. According to guidelines issued by the National Heart, Lung, and Blood Institute, a goal of proper asthma care is eliminating or at least reducing emergency room visits.[16] We also found that low-income asthmatic children, who have been shown to have inadequate asthma control,[17] were more likely to be enrolled in special education. Our findings support the possibility that children whose asthma is not under control are more at risk than children whose asthma is under control of suffering learning difficulties that result in special education enrollment.

Use of asthma management devices, such as peak flow meters and spacers, was less common among asthmatic children in special education than among asthmatic children in general education. Many studies have linked the use of asthma management devices to improved child health outcomes in that these devices increase disease awareness and monitoring and ensure proper medication delivery.[18,19] Yet, these devices are often not used in low-income, urban populations, contributing to asthma exacerbations.[20,21] Inadequate asthma control among asthmatic children in special education is not only attributable to improper asthma management. For example, urban children are more likely to be exposed to environmental triggers, such as diesel exhaust, that can exacerbate their asthma and lead to emergency department visits and hospitalizations.[22–24]

Another marker of inadequate asthma control is chronic absenteeism. Several studies have documented increased absenteeism among asthmatic children.[1,7,25,26] Chronic absenteeism, for any child, can lead to greater risks of grade failure.[27] Thies found that children with asthma were more likely to have multiple brief absences as opposed to prolonged absences from school; these types of absences accumulate over time, making it increasingly difficult for a child to catch up and then keep up academically with the rest of the class.[28]

We found that children with asthma who were enrolled in special education were absent an average of 1 day more during a given 2-week period than children with asthma in the general school population. This result was not statistically significant and may not have fully accounted for the marked increase in asthmatic children's risk of special education placement. However, as found by Thies,[28] these additional absences accumulate over the course of a school year, potentially creating large differences between asthmatic children enrolled in special education and those in the general school population.

Another factor that may have contributed to asthmatic children being enrolled in special education was that they were more likely to take medication during school hours. Many of these children need to visit the school nurse or health office to take their medications, leading to missed class time. Our results, together with the findings of previous research, illustrate the problems of absenteeism and missed class time among asthmatic children.[29] Overall, these results point to an avenue of further research aimed at determining whether improving asthma management and control can enhance child outcomes and avoid special education placements.

Celano and Geller concluded that, because asthma and its symptoms can be managed effectively, the illness alone does not warrant placement in special education, even if a child's academic performance is lacking.[30] Yet, asthma is often not properly managed, and this is especially the case among low-income urban children.[13,31,32] The question arises, then, whether these asthmatic children have one of the state-recognized disabilities used by the New York Department of Education to determine special education eligibility or whether, as suggested in recent articles, there is no system, other than special education, available in public schools to deal with an uncontrolled, chronic disease such as asthma and its educational consequences.[28,33,34]

Our results show that asthmatic children's enrollment in special education is associated with inadequate asthma management and low socioeconomic status. Because children spend so much of their time in school, there is an opportunity for public health interventions during the school day aimed at improving asthma control among children who are at risk or already experience learning difficulties. In a previous study, Clark et al. found improvements in school performance among children enrolled in a clinic-based asthma self-management program that had been transferred to the school setting.[35,36]

Strengths and Potential Limitations

Percentages of children receiving special education services were consistent among the 3 geographic sampling strata defined according to hospitalization rates, suggesting that bias in special education referral practices related to geography or school district was not introduced into the sample. It could be suggested that children in special education are more likely to be diagnosed with asthma because they are more closely monitored by teachers and parents. If this were the case, one would expect to see a greater number of general education students with asthma-like symptoms or conditions but without an asthma diagnosis.

However, we found no significant differences among students without an asthma diagnosis in prevalence of allergies, chronic bronchitis, history of wheezing, wheezing in the previous 12 months, and evening symptoms in the previous 12 months between the general and the special education populations, making it unlikely that differential diagnosis was an issue. In addition, children in special education were more likely than children in the general school population to have a caregiver with less than a high-school education, and previous research has shown an inverse relation between parental education and risk of an asthma diagnosis.[37,38]

Conclusions

We found that urban children with asthma, especially those in families with low incomes, are more likely than children without asthma to use special education services. In addition, we found that asthmatic children enrolled in special education are more likely to have uncontrolled asthma marked by use of urgent care services and inadequate asthma management. Finally, we found that the relation between enrollment in special education and some aspects of asthma management is mediated by socioeconomic variables and participation in asthma management or education programs. Overall, our results suggest that inadequate asthma control may contribute to a

greater risk of special education placements among urban, asthmatic children. ■

About the Authors

Jeanette A. Stingone and Luz Claudio are with the Department of Community and Preventive Medicine, Mount Sinai School of Medicine, New York, NY.

Requests for reprints should be sent to Luz Claudio, PhD, One Gustave Levy Pl, Box 1057, New York, NY 10029 (e-mail: luz.claudio@mssm.edu).

This article was accepted January 22, 2006.

Contributors

Both authors designed the study, analyzed and interpreted the data, and wrote the article.

Acknowledgments

This work was funded by SEARCH with support from the New York State Assembly, by the US Environmental Protection Agency, Region 2 (grant R827039 to the Mount Sinai Center for Children's Environmental Health and Disease Prevention Research), and by the Environmental Justice and Healthy Communities Program of the Ford Foundation.

Thanks to Leon Tulton for research assistance and to Advocates for Children of New York Inc for providing information about criteria for enrollment in special education in New York City. Also, we would like to extend a special thank you to all of the principals, teachers, parents, and students who participated in this study.

Human Participant Protection

This project and the associated informed consent protocols were reviewed and approved by the Mount Sinai institutional review board and the proposal review committee of the New York City Department of Education's Division of Assessment and Accountability.

References

1. Mannino DM, Homa DM, Akinbami L, Moorman JE, Gwynn C, Redd SC. Surveillance for asthma—United States, 1980–1999. *MMWR Morb Mortal Wkly Rep.* 2002;51(SS1):1–13.

2. Lozano P, Sullivan SD, Smith DH, Weiss KB. The economic burden of asthma in US children: estimates from the National Medical Expenditure Survey. *J Allergy Clin Immunol.* 1999;104:957–963.

3. Gendo K, Sullivan SD, Lozano P, Finkelstein JA, Fuhlbrigge A, Weiss KB. Resource costs for asthma-related care among pediatric patients in managed care. *Ann Allergy Asthma Immunol.* 2003;91:251–257.

4. New York City Dept of Education. Vital statistics. Available at: http://www.nycenet.edu/offices/d_chanc_oper/budget/dbor/VS/Vitalstatistics03.pdf. Accessed June 7, 2006.

5. Still waiting, after all these years: inclusion of children with special needs in the New York City public schools. Available at: http://www.lrecoalition.org/documents/LRErep10–23-01.pdf. Accessed June 7, 2006.

6. New York City Board of Education. Special education services as part of a unified service delivery system. Available at: http://www.nycenet.edu/NR/rdonlyres/69D78629-9B1B-4247-A23B-C09B581AFAB1/6454/ContinuumofServices.pdf. Accessed June 7, 2006.

7. Fowler M, Davenport M, Garg R. School functioning of US children with asthma. *Pediatrics.* 1992; 90:939–944.

8. Freudenberg N, Feldman CH, Clark N, Millman EJ, Valle I, Wasilewski Y. The impact of bronchial asthma on school attendance and performance. *J Sch Health.* 1980;40:522–525.

9. New York City Dept of Education, Division of Assessment and Accountability. Statistical summaries. Available at: http://www.nycenet.edu/offices/stats/default.htm. Accessed June 7, 2006.

10. New York City Dept of Education, Division of Assessment and Accountability. 2005 test scores. Available at: http://www.nycenet.edu/daa/test_results/. Accessed June 7, 2006.

11. Claudio L, Stingone JA, Godbold J. Prevalence of childhood asthma in urban communities: the impact of ethnicity and income. *Ann Epidemiol.* 2006; 16:332–340.

12. Claudio L, Tulton L, Doucette J, Landrigan P. Socioeconomic factors and asthma hospitalization rates in New York City. *J Asthma.* 1999;36:343–350.

13. Diaz T, Sturm T, Matte T, et al. Medication use among children with asthma in East Harlem. *Pediatrics.* 2000;105:1188–1193.

14. Asher M, Keil U, Anderson H, et al. International Study of Asthma and Allergies in Childhood (ISAAC): rationale and methods. *Eur Respir J.* 1995;8:483–491.

15. Clark N, Brown R, Joseph C, et al. Issues in identifying asthma and estimating prevalence in an urban school population. *J Clin Epidemiol.* 2002;55:870–881.

16. *Expert Panel Report 2: Guidelines for the Diagnosis and Management of Asthma.* Bethesda, Md: National Heart, Lung, and Blood Institute; 1997.

17. Stingone JA, Claudio L. Disparities in use of urgent health care services among asthmatic children. *Ann Allergy Asthma Immunol.* In press.

18. Yoos HL, Kitzman H, McMullen A, Henderson C, Sidora K. Symptom monitoring in childhood asthma: a randomized clinical trial comparing peak expiratory flow rate with symptom monitoring. *Ann Allergy Asthma Immunol.* 2002;88:283–291.

19. Cates CJ, Bara A, Crilly JA, Rowe BH. Holding chambers versus nebulisers for beta-agonist treatment of acute asthma. *Cochrane Database Syst Rev.* 2003; 2:CD000052.

20. Redline S, Wright EC, Kattan M, Kercsmar C, Weiss K. Short-term compliance with peak flow monitoring: results from a study of inner city children with asthma. *Pediatr Pulmonol.* 1996;21:203–210.

21. Celano M, Geller RJ, Phillips KM, Ziman R. Treatment adherence among low-income children with asthma. *J Pediatr Psychol.* 1998;23:345–349.

22. Chuang JC, Callahan PJ, Lyu CW, Wilson NK. Polycyclic aromatic hydrocarbon exposures of children in low-income families. *J Expo Anal Environ Epidemiol.* 1999;9:85–98.

23. Norris G, YoungPong S, Koenig J, Larson T, Sheppard L, Stout J. An association between fine particles and asthma emergency department visits for children in Seattle. *Environ Health Perspect.* 1999;107:489–493.

24. Perera FP, Illman SM, Kinney PL, et al. The challenge of preventing environmentally related disease in young children: community-based research in New York City. *Environ Health Perspect.* 2002;110:197–204.

25. Findley S, Lawler K, Bindra M, Maggio L, Penachio M, Maylahn C. Elevated asthma and indoor environmental exposures among Puerto Rican children of East Harlem. *J Asthma.* 2003;40:557–569.

26. Freeman NCG, Schneider D, McGarvey P. Household exposure factors, asthma, and school absenteeism in a predominantly Hispanic community. *J Expo Anal Environ Epidemiol.* 2003;13:169–176.

27. Dworkin P. School failure. *Pediatr Rev.* 1989; 10:310–312.

28. Thies KM. Identifying the educational implications of chronic illness in school children. *J Sch Health.* 1999; 69:392–397.

29. Halterman JS, Montes G, Aligne A, Kaczorowski J, Hightower AD, Szilagyi P. School readiness among urban children with asthma. *Ambulatory Pediatr.* 2001;1:201–205.

30. Celano MP, Geller RJ. Learning, school performance, and children with asthma: how much at risk? *J Learning Disabilities.* 1993;26:23–32.

31. Lieu TA, Lozano P, Finkelstein J, et al. Racial/ethnic variation in asthma status and management practices among children in managed Medicaid. *Pediatrics.* 2002;109:857–865.

32. Shields A, Comstock C, Weiss KB. Variations in asthma care by race/ethnicity among children enrolled in a state Medicaid program. *Pediatrics.* 2004; 113:496–504.

33. Lynch E, Lewis R, Murphy D. Educational services for children with chronic illnesses: perspectives of educators and families. *Exceptional Child.* 1993;59:210–220.

34. Students with chronic illnesses: guidance for families, schools, and students. *J Sch Health.* 2003; 73:131–132.

35. Clark N, Feldman C, Evans D, Wasilewski Y, Levison M. Changes in children's school performance as a result of education for family management of asthma. *J Sch Health.* 1984;54:143–145.

36. Kaplan D, Rips J, Clark N, Evans D, Wasilewski Y, Feldman C. Transferring a clinic-based health education program for children with asthma to a school setting. *J Sch Health.* 1986;56:267–271.

37. Nelson DA, Johnson CC, Divine GW, Strauchman C, Joseph CLM, Ownby DR. Ethnic differences in the prevalence of asthma in middle class children. *Ann Allergy Asthma Immunol.* 1997;78:21–26.

38. Aligne CA, Auinger P, Byrd RS, Weitzman M. Risk factors for pediatric asthma: contributions of poverty, race, and urban residence. *Am J Respir Crit Care Med.* 2000;162:873–877.